1. Background

This section describes the guiding principles and associated activities that lead to development of the Departmentwide business case for technology-supported learning.

1.1 Guiding Principles

On May 3, 1995, the Secretary of Energy issued a report entitled "Saving Dollars and Making Sense." In response to the report, in August 1995, Strategic Alignment Implementation (SAI) Plans were issued to reduce travel (SAI 36), integrate information management (SAI 39), and develop a corporate approach to training (SAI 44). These plans prompted customer calls for help in implementing technology-supported learning from a number of Department of Energy (DOE) organizations.

In addition, the Information Technology Management Reform Act (ITMRA) was introduced in 1995 and enacted by Congress in 1996 "to facilitate, encourage and provide for efficient and effective acquisition and use of modern information technology by executive agencies"; and "to increase the responsibility and public accountability of the heads of the departments and agencies of the Federal Government for achieving substantial improvements in the delivery of services to the public and in other program activities through the use of modern information technology in support of agency mission; and for other purposes."

1.2 Strategy

Based on the guiding principles above, and the fact that advanced training technologies are rapidly maturing, the Office of Training and Human Resource Development and the Office of Information Management partnered to establish an information sharing forum for all Departmental elements with interest in technology-supported learning. Representatives from DOE administrative and program offices and laboratories, other Federal agencies, educational institutions, and the private sector, participated in four video teleconferences between June and October 1995. This partnering effort produced a Departmentwide vision, mission statement, and goals for technology-supported learning. These products were used to formulate Departmental strategy in the form of an action plan (appendix A). The vision, mission, goals, and the action plan critical milestones are provided in the following sections.

1.2.1 Vision

Learning needs in the Department of Energy will be effectively met through a mix of traditional instructional methods and the use of compatible technology-supported learning tools, which will continually improve learning effectiveness.

1.2.2 Mission

Systematically identify the Department's learning needs and, where technology-supported learning is determined to be the medium, facilitate the identification and development of technology-supported learning-based solutions and instructional methods.

1.2.3 Goals

The first eight goals were developed by participants in the four video teleconferences. Three additional goals were developed by workshop participants directly involved in the development of the business case. Goals 1, 2, 4, and 8 were addressed during the research and development of the business case. Goals 3, and 5 through 11 involve issues that will be addressed during implementation planning and execution.

1. Identify equipment, technology, and other resource requirements and baselines for the effective implementation of technology-supported learning.

2. Evaluate the readiness of the Department and the policies and standards required to optimally harness technology-supported learning.

3. Identify instructional strategies and methods that will improve the quality and effectiveness of technology-supported learning activities.

4. Identify Federal and contractor learning activities that have cross-cutting applicability that would make them candidates for implementation via technology-supported learning approaches.

5. Develop standards for technology-supported learning format, structure, and process that will promote uniformity, reduce duplication of effort, and improve usefulness.

6. Identify evaluation criteria and parameters to measure the instructional effectiveness and cost savings associated with technology-supported learning as an alternative to conventional learning activity delivery.

7. Conduct pilots to validate system readiness, demonstrate the effectiveness of technology in improving learning outcomes, and evaluate cost versus performance.

8. Develop a cooperative relationship with other government agencies, the private sector, universities, laboratories, and other educational institutions involved in technology-supported learning, to share resources, products, and lessons learned.

9. Optimize the use of existing Departmental technology-supported learning facilities and capabilities (e.g., Central Training Academy, Energy Training Center, and contractor facilities).

10. Eliminate redundancies in cross-cutting training and education course development and delivery to reduce costs, increase efficiency, achieve the highest quality courses, and establish Departmentwide consistency.

11. Provide optimal training and educational opportunities throughout the DOE complex to maintain technical competence.

1.2.4 Critical Milestones

The action plan critical milestones for technology-supported learning, with current status, are provided below.

1. **Identify a home.** The Office of Training and Human Resource Development has been identified as the home for technology-supported learning.

2. **Establish a charter.** A draft charter, which proposes creation of a Departmentwide steering committee for technology-supported learning, has been distributed to both the Training and Information Management communities of interest for review and comment.

3. **Institute a partnering agreement.** A draft partnering agreement, which is intended to partner the Training and Information Management communities of interest, has been distributed for review and comment.

4. **Develop a business case.** This product comprises the business case. A business case development effort was needed to determine the feasibility of establishing and investing in a corporate technology-supported learning program. Business case results and recommendations will be reported to various training and information management managers and groups within the organization, up to and including the DOE Training and Development Management Council, and the DOE Executive Committee for Information Management.

5. **Develop a master plan.** A master plan for technology-supported learning will be developed when business case recommendations are approved and resources are allocated.

1.3 Technology-Supported Learning

The following sections provide a definition of technology-supported learning, an overview of major delivery methods currently in use, typical benefits, and some of the advantages and disadvantages of each method.

1.3.1 What is Technology-Supported Learning?

Technology-supported learning is synonymous with the United States Distance Learning Association (USDLA) definition of distance education, which states:

> "Distance Education refers to teaching and learning situations in which the instructor and the learner are geographically separated, and therefore, rely on electronic devices and print materials for instructional delivery. Distance Education includes distance teaching--the instructor's role in the process, and distance learning--the student's role in the process."

The term "technology-supported learning" is used in this business case to ensure differentiation from the premise or supposition that "distance education" and "distance learning" are only associated with interactive television (ITV) and transmission via satellite. Technology-supported learning implies various advanced training technologies including ITV, multimedia (MM) and computer-based training (CBT), and Internet and web-based training. These advanced training technologies will be used to aid instructors teaching at a distance (via ITV) or to enable students to learn on their own, at their desktops or in multimedia-equipped (and often Internet-connected) learning centers. While ITV typically allows students to query the instructor directly for help, students learning at their desktop or in a learning center may receive assistance from telephone help lines, online help desks, or live proctors.

1.3.2 Representative Technology-Supported Learning Delivery Methods

Several technology-supported learning delivery methods are fully mature, widely accepted, and extensively used by all branches of the military, numerous Federal agencies, many fortune 500 companies, and by an increasing number of educational and vocational training institutions. The following sections provide brief overviews of the current types of technology-supported learning delivery methods, their primary technology features, and some high-level advantages and disadvantages associated with each method. Some common training technologies (e.g., audio teleconferencing and instructor-led videodisc and CD-ROM-based presentations) have been omitted because of their similarity to those being presented. Many new technologies that are not described below are currently being field tested and will be emerging for wide-spread use within the next few years.

1.3.2.1 Interactive Television

Interactive television is a very common technology-supported learning delivery method. With this delivery method, the instructor and the student are physically separated, but connected through video, audio, and sometimes data links. The use of ITV provides opportunities to acquire custom-converted or re-purposed (modified) training from vendors. It also provides wide-area telemeeting capabilities with participant voting abilities, and allows multi-site, real-time project/program coordination and evaluation. The following are examples of ITV configurations.

Two-way video, two-way audio (terrestrial and satellite). This type of ITV utilizes video and audio links that connect the instructor to one or more student location(s) through video teleconferencing equipment.

> ***Terrestrial***. Commercially available video teleconferencing units use terrestrial lines (e.g., ISDN, T1, FTS 2000-SCVTS, FTS 2000-CVTS) for the delivery of instruction. DOE sites already utilize this type of technology for video teleconferencing.

Advantages of this type of ITV include lower initial costs than satellite transmission and quick set-up of the equipment for learning activities. Disadvantages are somewhat poorer video quality than is possible with satellites, a limited number of students can be connected in a session, special telephone lines must be installed to achieve limited video quality, and the high cost of using terrestrial lines for lengthy learning activities.

Satellite. Commercially available two-way video, two-way audio, is possible via satellite. This transmission method requires an expensive, uplink capability at each participating site. It is, therefore, not widely used for training applications.

One-way video, two-way audio (satellite and terrestrial). Currently, this is the most commonly utilized type of ITV. It incorporates the satellite delivery of live audio and video input from the uplink studio, usually showing an instructor, a panel of experts, still graphical images and/or pre-taped video segments. Students interact with the instructor in real-time via common telephone lines. This is the method used by the Office of Nonproliferation and National Security, Central Training Academy in Albuquerque, New Mexico.

An advantage of this type of ITV is that the satellite transmissions can reach all DOE downlink sites using one satellite broadcast. This is a more cost-effective method of delivery when needed for a large audience spread across the nation. In addition, the video and audio are of higher quality than that found in terrestrial-based video teleconferencing.

A disadvantage of this type of ITV is that it may not be cost-effective for teaching small numbers of students, even after installation costs have been expended. This is due to the current high costs for producing courses and procuring satellite time. Training a small number of students could be cost-effective or at least justifiable if the urgency of a course were great or if travel expenses for either the instructor(s) or students were found to be greater than the operational costs.

One-way video, two-way audio with data link (satellite and terrestrial). This format is the same as one-way video, two-way audio described above, except that a data link (e.g., X.25) is added. This link enables real-time testing and monitoring of student understanding by the instructor. Students use a response pad to key-in answers to questions or to signal the instructor that they wish to speak or need help. The instructor has a special monitor that summarizes response data or cues the instructor on who needs help or wishes to speak.

One-way video, one-way audio (satellite). This format is used by many universities to broadcast courses. Examples are the National Technological University (NTU) and the Mind Extension University (ME/U). Often the training or educational institution provides video taped courses for delayed distribution. Instructional materials are distributed by facsimile, U.S. mail, overnight delivery, world-wide web downloads or electronic mail. Learning activity facilitators may be required at each receiving site to assist in distributing material and proctoring exams. Student-instructor interaction does not occur during the instructional process, but is after-the-fact (often through the use of phone calls or fax messages. Therefore, the instructor cannot as quickly monitor and adjust the instruction to clarify concepts and follow student interests.

Some of the advantages of this format are relatively low costs for the delivery of learning activity content and the fact that consistent information is delivered to all sites. Disadvantages include the impersonal nature of the instruction and the lack of real-time interactivity between the instructor and student, which can increase the potential for misunderstandings. Learning activities that require students to perform complicated tasks that could be clarified through interactivity during the instructional process cannot be delivered via this type of ITV.

1.3.2.2 Multimedia/Computer-Based Training

Multimedia and computer-based training (CBT) are technology-supported learning delivery methods in which the student's primary learning tool is a personal computer. The computer is located either at the desktop or, more commonly, at a properly equipped learning center. The learning activity content is typically created by an instructional designer, stored on a compact disc-read only memory (CD-ROM) or laserdisc, and delivered via the personal computer. The computer typically controls the pace and direction of the instructional process, often utilizing sophisticated instructional algorithms to sequence and provide presentations for the learning activity. The student is able to receive the specific training that he/she needs, when and where it is needed. Multimedia/CBT learning activities range in complexity from simple self-guided slide shows to life-like simulations. Costs vary with complexity.

The main advantage of this delivery method is that it best facilitates "just-in-time training" or "learning on demand." This technology also allows a site to customize courseware to meet site-specific personnel needs. The primary disadvantage of multimedia and CBT is the lack of interaction with a live instructor, though this disadvantage is often compensated for by careful instructional design that anticipates student questions and has pre-stored answers, the presence of a live proctor in the learning center, or by having a help line or an electronically accessible help desk.

The following sections briefly identify the main categories of multimedia/CBT along with a typical application for each category. Successful implementations have shown very high learning and course compression rates. These advanced types have typically been very expensive to develop and deliver, but as with simulations, they have their place when safety, health, and other conditions justify their use. The most advanced types of CBT, such as intelligent tutoring systems and virtual reality training, are not described here, but they are being used in special situations.

Slide Shows and Linear Computer-Based Training. This is a low-end (in terms of complexity and cost) delivery system of learning activity information. The computer is, quite simply, a page turner that presents instruction in a sequential fashion. After the student reads/views one screen of information he/she pushes a key and progresses to the next screen in sequence. The instructional process may include interspersed quiz or exam questions with answer recording and processing. The instruction may include a final exam. However, the student's understanding is not evaluated by the computer during the process of learning and no instructional delivery decisions are made related to the student's level of understanding.

Drill and Practice. This involves the repeated presentation of questions or scenarios in a topical area. The student practices the application of knowledge previously learned. It is particularly useful for teaching factual information. It may be an integral part of a more complex learning activity or may be used by the student prior to taking an exam. This method is also low-end in terms of complexity and cost.

Learner-Selected Branching. This form of CBT offers the student some options with respect to which part(s) of the learning activity to take, as well as flexibility in sequencing. This form enables the student to "zero-in" on unfamiliar aspects of the learning activity and, if desired, skip the sections that are known. This may be used as a more time-efficient way to conduct refresher training. It is much more complex and costly than straight slide-show/linear CBT.

Canned Simulations. This form of CBT usually involves a film clip or animation of a process or procedure that the student is expected to learn. It may be integrated into a larger learning activity involving any of the above styles. It is more costly due to the need for producing graphics (video, stills, or animation) in addition to audio or text. The students can practice performing some procedure or observing some process, but typically must conform to the pre-programmed sequence. There is very little built-in intelligence in the courseware.

Fully Interactive Simulations. This form of CBT has a high degree of complexity and cost. It involves context-sensitive student interactivity and involvement in the simulation being presented. It can be useful for demonstrating complex tasks and processes that might otherwise put the student at a safety risk. If the student chooses an incorrect option, the simulation re-presents the key points, often in a different way. The interactive simulation protects the student from injury or embarrassment, while allowing him/her to learn the correct or responsible actions. Often using high quality, computer-generated graphics coupled with realistic audio, this type of simulation can have a video-game-like feel, which may be described as a limited application of virtual-reality technology. Such complex simulations approach the effectiveness of on-the-job training in a mock-up environment. Extensive knowledge of the system must be modeled and programmed into the courseware.

1.3.2.3 Internet/Intranet-Based Training

These delivery methods are virtually identical to the multimedia/CBT methods with one exception: high-speed networks allow training to be delivered to and used by students who are geographically distant from the computer that holds and controls the instructional program. The instructional program is delivered to a student’s computer over the network to which a student’s computer is connected (local or wide area network, dial-up connection to the Internet, or a local intranet). The instructional program and any required support files are transmitted over the network and displayed on the student's computer, which uses a special multimedia player or a World Wide Web browser, such as Netscape Navigator. The Internet can also be used to support traditional training delivery methods by providing for downloadable course outlines, lecture notes and slides, reading materials, supplemental media clips, private electronic mail-based answers to questions, and online group discussions.

The most significant advantages that network-delivered training have over multimedia/CBT are the low-cost of getting the courseware to the students and the improved ability to maintain configuration control throughout the system as updates are made to the learning activities. The widespread use of the Internet will also enable centralized coordination of Departmental course catalogs, learning activity registration, and access to other global information.

Currently, Internet bandwidth limitations prevent wide-spread use of media-intensive content, as a few seconds of high fidelity video or audio can require several megabytes of data to be transferred from the host to the student's computer. Many Internet training applications are using locally stored media content (on CD-ROMs) to augment Web-based training interactions.

1.3.3 Benefits of Using Technology-Supported Learning Delivery Methods

The use of technology-supported learning, which incorporates the advanced training technologies described in section 1.3.2, as well as other newly emerging technologies, offers the Department of Energy many potential benefits that have been extensively documented. The following is an excerpt from an article by Larry D. Moulds, Ph.D., entitled "Using Distance Learning in the Training of Adult Learners" published in the United States Distance Learning Association publication *ED Journal*, Volume 10#6, June 1996.

"Technology-based interactive learning has the following potential benefits (Dennis, 1994; Kearsley, 1990; Wilson, 1991):

1. Reduced learning time - typically 30-40% less time is required compared to classroom instruction.

2. On-demand learning - instruction is available when and where the learner needs it. No need to wait for or travel to a scheduled class. Increases access to learning for the disabled.

3. Increased motivation - students usually report that they find technology-based interactive learning more interesting and enjoyable than classroom lectures.

4. Increased achievement - when corrective feedback or a mastery learning strategy is provided, students often show better test results, retention, or job performance from technology-based interactive learning.

5. Better quality control - since learning experiences are delivered in the same way each time, [they] are much more consistent and reliable than classroom instruction.

6. Increased safety - learners can learn about and practice dangerous procedures without a safety concern.

7. Greater flexibility - fluctuations in the number of learners or their backgrounds can be accommodated more easily than with classroom instruction.

8. Improved accountability - automatic collection of data on learner performance can verify learning accomplished and identify learning problems.

9. Faster revision - to the extent that the learning experiences are delivered via a networked system, changes and updates to information can be made immediately.

10. Reduced delivery costs - once developed, technology-based interactive learning is likely to cost less relative to labor intensive classroom instruction. It can also be used instead of expensive equipment.

11. Learner controlled - each learner is able to review topics or to skip beyond the information they already know."

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